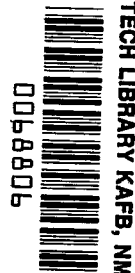


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VOLCANIC ACTIVITY ON MARS

by G. N. Katterfel'd

Priroda, No. 8, 1965

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VOLCANIC ACTIVITY ON MARS

G. N. Katterfel'd

ABSTRACT

The Mars opposition occurred in March, 1965 - the most favorable time for observing its surface from the earth. Many astronomers pursued a great many studies at this time, which provided new information about Mars. Therefore, the present article has become timely. The author of this article has utilized many data published during the last 55 years, primarily data obtained by Japanese astronomers which are almost unknown to the Soviet reader.

The phenomenon of volcanic activity on the moon is generally /103* known at the present time. One of the first observations of this type was performed on May 4, 1783, by William Herschel. N. A. Kozyrev carried out such observations comparatively recently - November 3, 1958, and October 23, 1959.

There is much less information about the phenomenon of volcanic activity on Mars. However, very interesting theoretical and observational data have been obtained about this activity during the last 10 - 15 years. Taking into account the comparative meagerness of our areological¹ information, these results undoubtedly merit attention and further study.

The first hypothesis regarding volcanic activity on Mars was formulated by the well-known Greek researcher on this planet, E. M. Antoniadi

*Note: Numbers in the margin indicate pagination in the original foreign text.

¹From the Greek Arey - Mars. Areology - "geology" of Mars. It is etymologically incorrect to employ the term geology and the expressions related to it when referring to this planet, since the word geology originates from the Greek name for the earth.

who worked at the Meudon Observatory (France). While observing the Martian Deucalionis Regio (see map of Mars attached) during the opposition of 1909 and 1911 on the 83-centimeter refractor of this observatory, he detected unusual grey clouds close to it. Due to the fact that they definitely did not belong to the white nebulae and reddish dust storms usually observed on Mars because of their color, Antoniadi attributed a volcanic origin to these clouds.

HYPOTHESIS OF McLAUGHLIN

In 1954-56, the Michigan astronomer D. McLaughlin expressed his theoretical ideas regarding Martian volcanic activity in six articles ("Volcanic Activity and Eolian Deposits on Mars", "Wind Systems and Volcanos on Mars" etc.) In the opinion of this author, there are numerous volcanos on Mars located at the head of "sea" inlets. The ashes which they eject are scattered by the winds, and are systematically deposited on the Martian surface, forming linear "canals" and dark "sea" coverings of a greenish color. This color is determined by minerals such as chlorites and epidotes, which are formed in the presence of CO_2 and H_2O in an atmosphere devoid of oxygen during the disintegration of ferro-magnesium minerals which are contained in the volcanic ash. Although there are rational ideas in the areological works of McLaughlin (for example, regarding the role of eolian processes caused by the wind in forming the relief of the Martian surface), his initial hypothesis regarding intense volcanic activity on Mars cannot be accepted. Arguments in opposition to the theory advanced by McLaughlin have been so convincing that it has been refuted, and has not received recognition even among a few areologists. The main objection lies in the fact that the color of the dust storms observed on Mars is yellow, and not black or greyish-black which would have to /104 be the case according to the hypothesis of McLaughlin, and that the actual color of the "seas" is not green. In the opinion of many scientists, these "seas" have vegetation and "canals". These are not ejections of volcanic ash which are carried and deposited by narrow wind streams (from a meteorological point of view, these ideas have also been regarded as incorrect), but bands of vegetation which fix tectonic ruptures of the lithosphere on Mars. Wind erosion and wind removal lead to the formation of troughs along these ruptures.

Thus, the founder of areography, J. Schiaparelli, spoke about the /105 Martian "canals", stating that "the network of these canals on the surface of the planet was initially caused by geological (in the figurative meaning of this word) formations on the surface of Mars, and slowly developed throughout the centuries".

All of the Soviet and foreign geologists-areologists are presently searching for a tectonic explanation of the Martian linear formations. The following are included among this group: A.V. Khabakov (Leningrad),

¹See G.N. Katterfel'd, "Problem of the Tectonic Origin of Linear Formations on Mars (K voprosu o tektonicheskom proiskhozhdenii lineynykh obrazovaniy Marsa). Izvestiya Geograf. Obshchestva SSSR, Vol. 91, No. 3, 1959.



Figure 1

View of Mars in the 33-inch Refractor of the Meudon Observatory. Region of the Cimmerium Mare. The Circle Denotes the Location of the Center of a Grey Cloud Observed by Ts. Sayeki in 1950. Longitude of the Central Meridian is 231° . (According to a Figure by E. Antoniadi, September 5, 1924). In the Southern Hemisphere (above, slightly to the right): Electris, Eridania, Amazonis, Hellas. Eridania is the Location where Grey Clouds Have Been Observed Several Times; it is Assumed that These Clouds are Caused by Volcanic Activity. This Region was Discovered by the Berlin Astronomer Yu. G. Hale in 1839 Using a 9.6-inch Refractor. The Trivium Charontis and the Elysium Plateau can be Clearly Observed in the Northern Hemisphere.

Yu.A. Khodak (Moscow), P.M. Frolov (Moscow), Kurd von Bülow (Rostok, Germany), and Konrad Benesh (Ostrava, Chuvash SSSR). The well-known American astronomer Clyde Tombaugh (who discovered the planet Pluto in 1930) previously supported the meteorite hypothesis for the origin of the reticular system on the surface of Mars, but now he also tends towards the areological-tectonic interpretation of the Martian linear formations.

If about 1 km^3 silicate masses and water are ejected as the result of volcanic processes on the earth's surface each year, it can be readily shown that the amount of these materials on Mars must be considerably less. In actuality, the total amount of water accumulated on the surface of Mars is equivalent to several millimeters within the region of polar caps, and is equivalent to a layer of 0.01 mm beyond this region. Thus, the global



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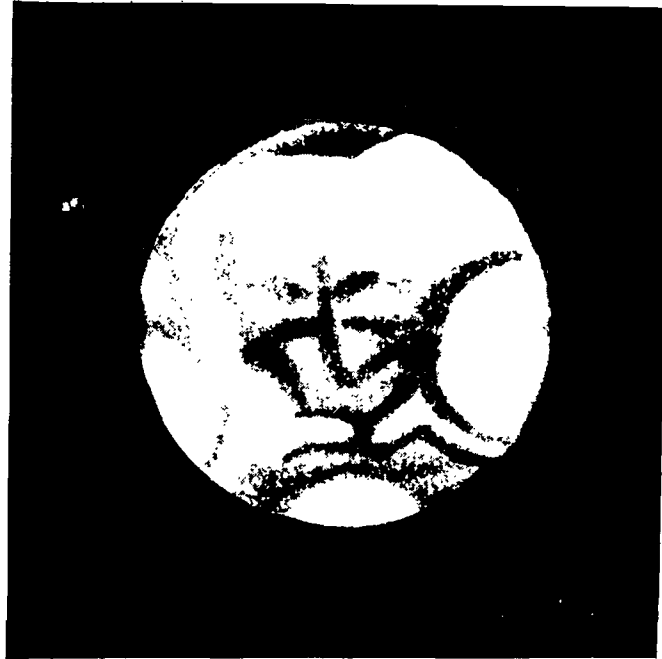


Figure 4

Grey Cloud Over the Southeastern Portion of the Sirenum Mare Projected on the Southern (upper) Edge of Mars. (According to a Figure of S. Ebizawa, Compiled on March 29, 1950, at 11 hours, 55 Minutes, World Time, When the Longitude of the Central Meridian Was 160°). In the Right Portion of Mars - the Elysium Plateau.

Mars. The cloud was located at an altitude of 100-200 km above the planet's surface. On March 29, 1950, S. Ebizawa (Tokyo), using a 6-inch reflector, observed a second, similar cloud over the southeastern portion of the Sirenum Mare (Figure 4). This cloud lasted for four days, and changed its color constantly.

In March and April, 1952, at the boundary of Eridania and the Mare Cimmerium (see attached map), Ebizawa again observed the grey clouds twice. Observations of the bright flares are given in the table. /106

All of these explosive-like phenomena, which are very unusual from the volcanic point of view and which have been observed on Mars not only in the last fifteen years, but also in the preceding years, enable one to draw very important conclusions.

According to the observations performed by different astronomers, the duration of the majority of flares is approximately the same and comprises about five minutes. The frequency with which the flares and the grey



Figure 5

Bright Flare on Mars Close to the Sithonius Lacus
on June 4, 1937 (According to a Figure by Sitzuo Mayeda).

clouds appear is comparatively high. They have been observed more frequently in the southern hemisphere than in the northern hemisphere, and they have been observed most frequently of all at 35° south latitude and at the equator.

These small bright spots and grey clouds appear, as a rule, either on the boundary of dark (lower) and light (higher) regions, or at the places where several "canals" intersect, close to the so-called "oases". In the tectonic sense, the canals represent extended ruptures of the Mars lithosphere, while the "oases" represent the rupture centers. The boundaries between the lower and higher regions are also determined by the ruptures in the majority of cases. Since the ruptures are the weak and most porous regions of the planet's core, along which degasification of its nucleus occurs, this localization can be most simply and naturally explained from the volcanic point of view. As the German planetologist Kurd von Bülow has pointed out, the process by which Mars' nucleus is degasified usually takes place smoothly along the rupture lines on its surface. However, during the explosive phase degasification does not occur along the boundaries of masses having different elevations, but is concentrated at the points where the ruptures intersect - "oases".

On the other hand, the regions on Mars where bright flares are observed apparently represent regions having a complex relief, where unusual meteorological conditions can exist. The rapid development of white cloud masses composed of water vapour ejected by live volcanos which explode intermittently can be connected in this case with the sudden development of water vapour





Figure 6

View of Mars in a 33-inch Refractor of the Meudon Observatory. Region of the Solis Lacus. Tithonius Lacus is Indicated by a Circle. Longitude of the Central Meridian is 87° . (According to a Figure of E. Antoniadi, December 4, 1911).

clouds around rapidly-rising jet streams in the atmosphere caused by complex meteorological processes above these regions.

If the location of the explosive-like phenomena which are observed on Mars is plotted on a map of Mars, one significant fact can be observed: they are not distributed in a random manner along the surface of the planet, but are confined within the narrow zone of the following five parallels: 0° (five or more flares); 35° north latitude (one flare or more); 35° south latitude (two or more flares and three grey clouds); 62° north latitude (one flare); and 62° south latitude (one grey cloud). In the geological literature, they are called "active parallels"¹ for the earth, due to the great seismic, tectonic, geomorphological mobility of the lithosphere and increased volcanomagmatic activity in the zones of influence of these parallels. Thus, the signs of active parallels in Mars' lithosphere, which were noted previously (G.N. Katterfel'd, 1959), must now include the distribution (which is zonal with respect to these parallels) of explosive phenomena observed on the surface and in the atmosphere of Mars in recent centuries. This feature, which has been discovered for the first time and which was not given any attention previously,

¹ See G.N. Katterfel'd. "Face of the Earth and its Origin" (Lik Zemli i ego Proiskhozhdeniye). Geografiz, Moscow, 1962.



Figure 7

View of Mars in a 33-inch Refractor of Meudon Observatory. /108
 Region of Sabaeus Sinus. Above - Deucalionis Regio, Location
 of Assumed Volcanic Phenomena Observed by Antoniadi.
 Edom Pr. is Indicated by the Cross, Longitude of the
 Central Meridian is 322° . (According to a Figure by
 E. Antoniadi, September 15, 1926).

serves as one argument in favor of the volcanic hypothesis.

Careful observational examination has not revealed small, white spots on Mars, which - if they existed - would indicate a network of volcanos to us. Only a few isolated white spots have been observed. This shows /109 that volcanic activity is less extensive on Mars than it is on the earth. This conclusion closely coincides with the insignificant amount of water on Mars in the solid state (frost on the Elysium Plateau, Tanais, Hellas, Olympia, etc. and the polar caps), as well as the insignificant amount of water vapour and carbon dioxide - which represent the by-products of volcanic eruptions, as is well known.

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 President, Planetology Commission of
 the All-Union Geographical Society
 (Leningrad)



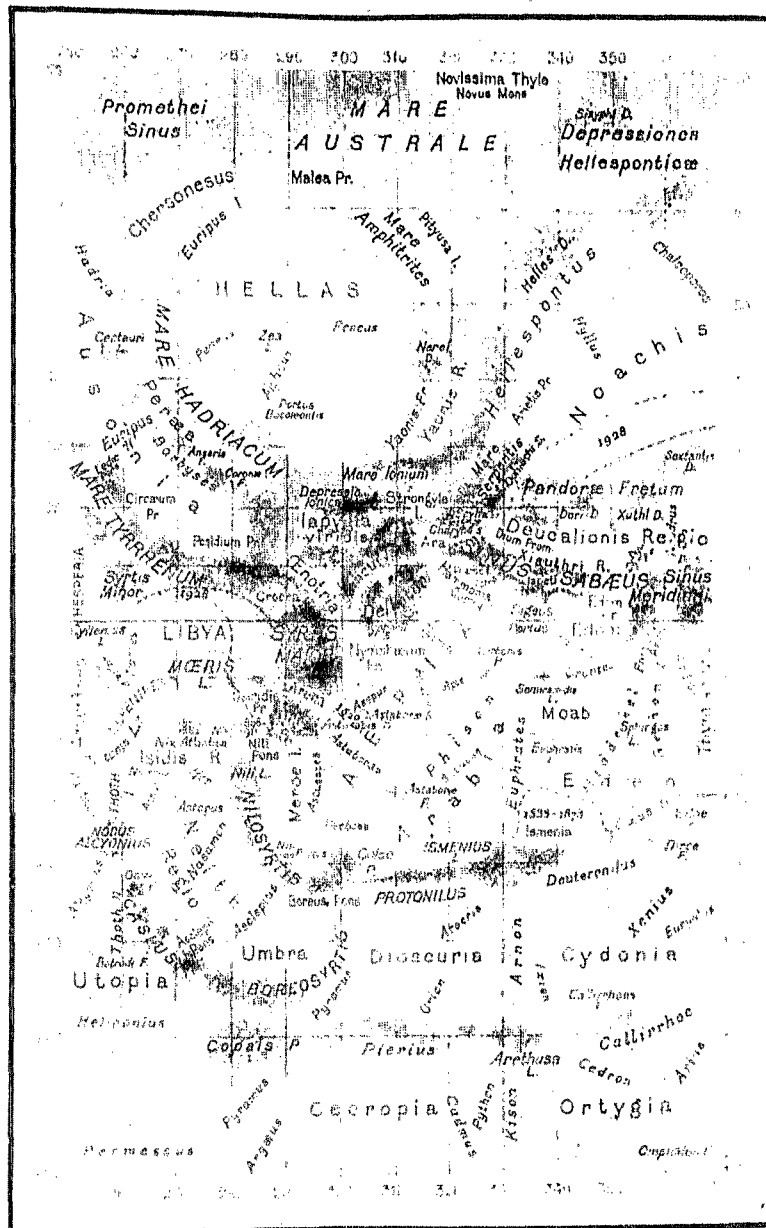
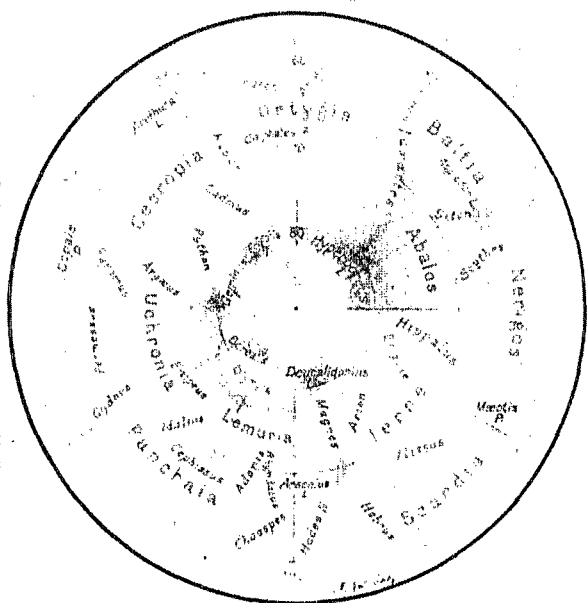
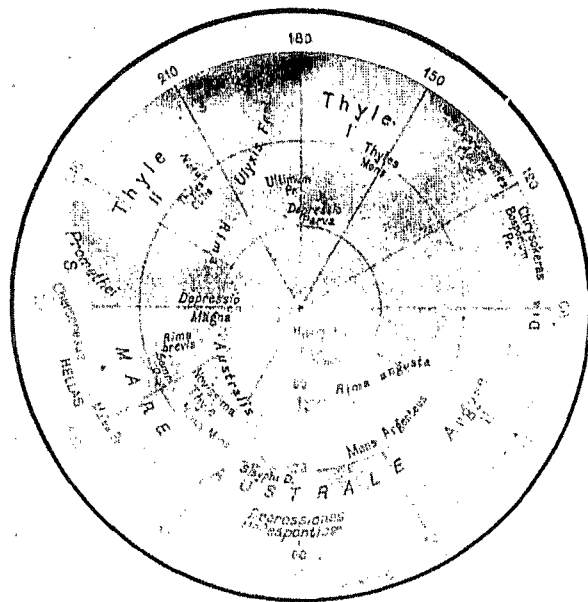
Figure 12

Bright Flares Above the Edom Plateau
on the Northern Edge of Hellas, November 21,
1958 (According to a Figure by Itsiro Tasaka)

derived from random observations of flares. It is necessary "to patrol" the surface of Mars, along with systematic observations by scientists in different countries during the appropriate seasons. If there were excellent weather throughout the entire surface of the earth, Mars could be observed throughout the entire period of nocturnal visibility. Very conclusive results could then be obtained regarding the rare phenomena described above. It would be possible to make definite statements regarding the frequency and actual distribution of flares and grey clouds on Mars. Up to the present, Mars has not been patrolled in this way. This has already been done with the Moon, and rich results can be expected in time.

The author of the article translated the names on the map of Antoniadi into Russian. There have been no definitive Russian translations of the areographical names up to the present.

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